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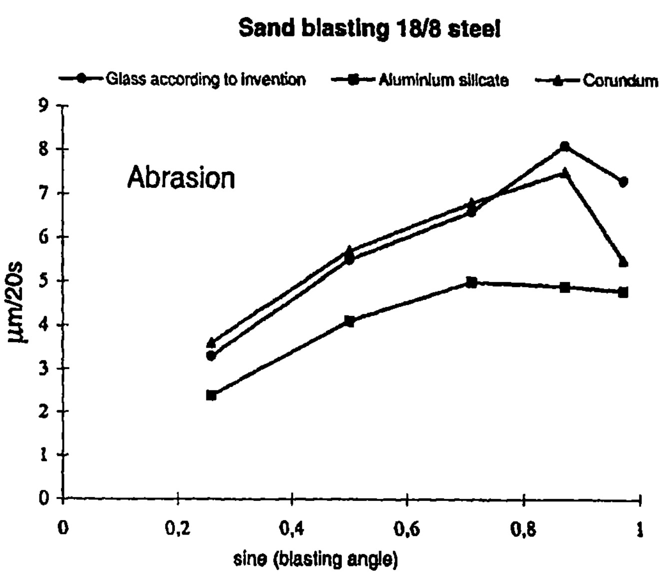
(54) Title: METHOD FOR PRODUCING A GLASS AND GLASS PRODUCED THEREBY



(57) Abstract: Glass produced on basis of a raw material in form of a mixture of mainly mineral-containing components comprising sludge from e.g. purification plants and waste products from the industry, and having a determined chemical composition adjusted on basis of knowledge of the chemical composition of the mineral-containing components forming part of the glass. The glass is produced from the raw material which after mineralization is pressed into briquettes that are hardened and subsequently melted in e.g. a blast furnace under oxygen supply, and where the melt is quenched and dried. Large amounts of waste products and waste substances that are normally deposited either treated or untreated can be reused and utilised at production of the glass.

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Method for producing a glass and glass produced thereby

The invention relates to a method for producing a glass made on basis of a raw material in form of a mixture of mainly mineral-containing components and where the base material after an initial pretreatment is pressed into briquettes that are hardened and subsequently melted in e.g. a blast furnace under oxygen supply, and the melt is quenched and dried.

The invention also relates to a glass of the kind made on basis of a raw material in form of a mixture of mainly mineral-containing components.

The invention furthermore relates to the use of the thus compound and made glass.

It is well-known among persons skilled in the art that sludge from municipal purification plants constitutes a large waste problem in most industrialised countries. The sludge can e.g. be generated at a chemical treatment of sewage water which subsequently is dewatered. The dewatered sludge typically consists of 70-80% water, 10-15% organic material and 10-15% mineral components.

Sludge waste can in either wet or dried form be spread as fertilizer on farmland. The content of the sludge of e.g. heavy metals and iron and aluminium phosphates of low solubility cannot be utilised by the crops and there is therefore a risk of these substances percolating into the ground water or destroying the soil structure.

Alternatively, dried sludge waste can be deposited in very large landfills. The space requirements to the landfills mean that such sites must be open. When the sludge is exposed to precipitation, a possible content of heavy metals and trace

elements will be leached out and pollute the surrounding environment.

An often used method for disposing of sludge waste is to incinerate the sludge. Hereby, an ash is produced that subsequently must be deposited. The above-mentioned heavy metals and iron and aluminium phosphates are now merely to be found in the ash, and the ash will at depositing result in the same leaching-out and percolation problems as mentioned above. To this should be added that the calorific value of dried sludge is very small compared to the calorific value of traditional combustibles. As an example of this, it can be mentioned that dried sludge has a calorific value of 12-13 MJ/kg which is about half of that of wood. The small calorific value therefore means that dried sludge only very occasionally is used as energy source.

The industry produces large amounts of waste products that only very rarely can be reused and therefore also constitute a significant and costly depositing problem.

By reusing the above waste products, the growing and therefore increasingly costly need for depositing areas can be reduced.

There is therefore a need for in an economically advantageous way reusing a wide range of waste products in order to thereby reduce the need and requirements to the depositing areas and without at the same time producing deposit material containing environmental harmful and health hazardous substances.

A first object of the invention is to provide a commercially applicable glass with great hardness and wearing resistance, in which sludge and a wide range of waste products from industrial machining and processing processes are used, and in which the content of the sludge and waste products of mineral-

containing, environmental harmful and health hazardous substances are made unavailable to the surroundings.

A second object of the invention is to provide a method for producing such a glass.

The novel and unique features according to the invention, whereby this is achieved, is the fact that the pretreatment mentioned in the opening paragraph comprises producing a mixture of mineral-containing components from sludge from e.g. purification plants and of one or several other mineral-containing waste products and/or natural rocks.

When the one or several mineral-containing waste products and/or natural rocks have a content of larger components, these can advantageously be reduced in size before entering into the mixture to thus provide a porous mixture that easily can be aerated.

When oxygen is admitted to such a mixture, the mixture will self-ignite, and the sludge content of fat, protein and soluble carbohydrate will be decomposed to water and CO_2 at a temperature of about 60 - 70°C.

The above thermal treatment of the mixture of mineral-containing components will in the following be called mineralization. Complete decomposition of fat, protein and soluble carbohydrate will typically be completed in 20-40 days.

The pretreatment includes subsequently that the water content of the mixture is adjusted to between 20 and 35 wt%, and preferably between 27 and 33 wt%. By adjusting the water content, the mixture will be suited for being pressed into briquettes, the dimensions of which are over 60 mm in an especially advantageous embodiment.

When the water content of the briquettes is greater than 35 wt%, the briquettes will not be solid or able to maintain a homogenous shape. At water contents of less than 20 wt%, there will be segregations that reduce the strength of the briquettes inexpediently.

Homogenous briquettes are packed and are best utilised in the later combustion process in e.g. a blast furnace.

By adjusting the water content of the briquettes as described above, the subsequent hardening of the briquettes can pass off optimally so that the briquettes maintain a homogenous shape. The hardening can e.g. take place at a temperature of between 75°C and 110°C until the briquettes have a water content of 15 - 20 wt%.

Examples of advantageous conditions of hardening are hardening at a temperature of 110°C for three hours, or a hardening at 80°C for six hours. In both cases, briquettes with an unhardened centre and a hardened shell are obtained.

By means of this hardening, non-hygroscopic briquettes can be produced that have a hard surface and a density of between 1.2 - 1.3 g/cm^3.

Due to the hygroscopic properties of the briquettes, these are very storage stable. Due to their exceptionally hard surface, they can stand violent mechanical handling. It is therefore possible to store the continuously produced briquettes and thus advantageously continuously dispose of waste material.

The briquettes are melted under oxidizing conditions in a blast furnace using known technologies to thus bring the entire mineral content of the melt to oxide form. As an example of known technology, the Anderson technique known from

US Patent No 3,729,198 can be mentioned but other forms of melting can also be used.

Only small amounts of elements, such as sulphur, zinc, or chlorine, are lost during melting as they can leave as sublimates.

The briquettes are melted into a glass at a temperature of between 1400 and 1500°C, and the specific structure of the briquette with an unhardened centre and a very hard surface causes the combustion reactions to pass off in both the centre and the shell of the briquettes. When the briquettes are given the above well-defined form and dimension, the combustion reactions will also take place in the gaps between the packed briquettes in the blast furnace.

Even though the energy content of the briquettes, in form of insoluble organic material, is smaller than the energy content of traditional fuels, it is possible to melt the briquettes with a minimum input of extra fuel by controlling the oxygen-containing supply air. The preferred fuel is coke which in an advantageous embodiment is not used in amounts greater than 10 wt% of the amount of briquettes that is to be melted.

In another preferred embodiment of the method according to the invention, the briquettes have an energy content that is sufficient for the briquettes to melt completely without the presence of extra fuel.

The resulting melt is quenched whereby a slag is formed that at least partly granulates of itself. This slag consists of 100% glass, i.e. often coloured black due to a content of iron oxide.

The granulated slag can subsequently be crushed and divided into smaller grains, the size of which depend on the envisaged

later application. The divided grains can, if desired, be fractionated by size to make a specific fraction especially suited for a later purpose.

By making a number of demands on the chemical composition of the mineral-containing components that form part of the raw material of the glass, a glass can be provided that has a hardness which is greater than 600, measured on Vickers hardness scale.

In accordance with the object of the invention, the raw material comprises besides sludge from e.g. a purification plant also one or several other mineral-containing waste products from the industry. These waste products can e.g. form part of the raw material as the only additional mineral-containing components.

As a first alternative to the above mixture, the raw material can be a mixture consisting of sludge, mineral-containing components and natural rocks. In another alternative raw material, the mixture can consist of sludge and natural rocks.

In order to be able to satisfy the demands on the chemical composition of the glass, it is necessary to know the chemical composition of all the constituent mineral-containing components.

Such a knowledge can advantageously and inexpensively be obtained by analysing the mineral-containing components by means of X-ray fluorescence.

The mixing of the different mineral-containing components can then be based on these analytical results so that by means of the method described above, a glass can be produced in which more than 30 wt% inorganic components originate from sludge.

Examples of mineral-containing waste products are:

Car shreds	:	the light fraction from car breaking
Hammer scales	:	oxide scales from rolling of steel
Moulding sand	:	used foundry moulding sand, including furan sand and bentonite sand
Garnet	:	used sandblasting sand of the garnet type, (almandite, a silicate of Al, Fe, and Mg)
Aluminium silicate	:	used sandblasting sand
Corundum	:	used sandblasting sand mainly in form of glass from bottom slag from electric power plants
Fireproof MgO bricks	:	fireproof molten metals or moulded bricks mainly made of the mineral periclase (MgO)
Chamotte bricks	:	fireproof materials made of the aluminium silicates silimanite and kaolin together with a small amount of quartz
Ash from PVC	:	Filler material from pyrolitic PVC and consisting of mixtures of TiO_2, $CaCO_3$, kaolin ($Al_2SiO_4(OH)$) and talc ($MgSiO_4$ (OH))
Paper waste	:	Waste material from manufacture of paper and consisting of wood fibres and mineral-containing paper filler material, such as lime, kaolin and talc

Such waste products can contain larger components which have to be divided into smaller particles before entering in the mineralization.

The chemical composition of the glass can be calculated from the knowledge of the chemical composition of the individual mineral-containing components that form part of the glass and that are advantageously combined in consideration of a number of chemical demands which means that the glass is hard and that its content of minerals that are harmful to the

environment and the health has been made unavailable to the surroundings.

The mineral content of the glass is at melting brought to oxide form and the weight percentage of the formed mineral oxides SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO and P_2O_5 together make up at least 90 wt% of the glass, and in an especially preferred embodiment, said mineral oxides together make up at least 95 wt% of the glass.

To give the glass having the above chemical composition a hardness that is greater that 600 on Vickers hardness scale and in which the content of minerals that are harmful to the environment and the health is made unavailable, the CaO/P_2O_5 ratio in the glass must furthermore satisfy the inequation

$$\text{wt\% CaO} \geq 1.33 * \text{wt\% } P_2O_5$$

and

$$\frac{(\text{wt\% CaO} - 1.33 * \text{wt\% } P_2O_5)) + \text{wt\% MgO}}{\text{wt\% } SiO_2}$$

which in the following is called the basicity (B_i) must be between 0.15 and 0.50 in the cases where (wt% CaO - 1.33 * wt% P_2O_5) > 0.

In order to get a balanced ratio between silicon dioxide, dialuminium trioxide and diferri trioxide, the chemical composition of the glass must also satisfy the demands that the silicate modulus

$$M_s = \frac{SiO_2}{Al_2O_3}$$

is between 2.2 and 3.2, and the iron modulus

$$M_f = \frac{Fe_2O_2}{Al_2O_3}$$

is between 0.56 and 1.00.

When the demands on the chemical composition are satisfied, the glass will have a specific density which is between 2.7 and 3.1 g/cm^3, preferably between 2.8 and 3.0 g/cm^3, and especially 2.9 g/cm^3.

When the above demands on the mineral oxides have been satisfied, a glass is obtained that mainly consists of the mineral oxides mentioned in Table 1 below. The glass will also have a very small content of microelements. The content of such microelements in the glass is indicated in Table 2. These microelements can be toxic or carcinogenic but have been made unavailable to the surroundings when the glass is produced by means of the method according to the invention.

Table 1

Mineral oxide	**Content in glass**
SiO_2	35-50 wt%
Al_2O_3	15-25 wt%
Fe_2O_3	5-15 wt%
CaO	5-20 wt%
MgO	1-10 wt%
MnO_2	< 1 wt%
TiO_2	< 3 wt%
P_2O_5	1-10 wt%
K_2O	< 2 wt%
Na_2O	< 2 wt%
Others	< 5 wt%

Table 2

Micro-elements	**Content in glass**	
Sb	< 0.007 wt%	Toxic micro-elements
Pb	< 0.020 wt%	
Cd	< 0.009 wt%	
Sn	< 0.043 wt%	
As	< 0.009 wt%	Carcino-genic micro-elements
Be	< 0.007 wt%	
Cr	< 0.001 wt%	
Co	< 0.007 wt%	
Ni	< 0.022 wt%	

A glass on which the above demands have been made to the chemical composition of the content of mineral oxides and which is produced by means of the method according to the invention, can most advantageously be used as blowing agent in sand blasting.

Alternatively, the granulated slag can be cast and used for producing slag wool.

Furthermore, the glass can, in cases where it is not used, be recycled as mineral-containing waste product in the glass according to the invention.

By means of the method according to the invention, a glass is produced in which environmental harmful and health hazardous substances are made unavailable to leaching. The glass can therefore also be used as filler for many purposes, for example in concrete and asphalt.

The many different forms of application of the glass according to the invention and the reuse of mineral-containing waste products mean that considerable amounts of costly raw materials can be saved. In addition the ever-growing amounts of waste products are reduced and the need for landfills is reduced considerably.

In the following examples of mixtures of raw material, the part of waste from industry and waste disposal is more than 95 wt%. The chemical composition of all types of waste is known and determined by means of X-ray fluorescence. In the following, the term sludge ash is applied to dried, thermal-treated, dewatered sludge. Other mineral-containing components are mentioned using the above designations:

Example 1 (laboratory scale)

The raw material consists of a mixture of 34.4 wt% sludge ash and 13.8 wt% shreds which are incinerated, and added 23.8 wt% foundry sand, 4.0 wt% fireproof MgO bricks, 5.6 wt% used Al_sO_3 and 18.4 wt% chalk. The mixture is crushed to a particle size smaller than 0.2 mm and heated in platinum crucible or laboratory furnace to 1450°C for 6 hours. The result is a melt

that granulates after quenching in water. Polarizing microscopy shows that the melt is a black glass with a density of 3.0 g/cm^3 and having a chemical composition as stated in Table 3 below:

Table 3

Mineral	**wt% of the total glass weight**
SiO_2	43.4
Al_2O_3	14.5
Fe_2O_3	9.2
CaO	18.1
MgO	5.4
MnO_2	0.1
TiO_2	0.6
P_2O_5	7.3
K_2O	0.9
Na_2O	1.0
SrO	0.3
SO_3	0.03
Others	-
Σ	100,8 wt%

The thus obtained glass has a basicity $B_i = 0.32$, an iron modulus $M_f = 0.63$ and a silicon modulus $M_s = 1.85$ and therefore satisfies the demands on the chemical composition.

The glass has been analysed for leaching at pH 4 and pH 7, respectively. The leaching was carried out with 100 l water per kilo glass for 3 hours. According to a normally applied standard method from "Vandkvalitetsinstitut" (= Institute of water quality) in Denmark, samples from both leachings were pooled and analysed by means of atomic absorption photometry and in graphite furnace. The following leaching results were hereby obtained:

Table 4

Mineral	**Leached concentration in ppm**	**% of original mineral content**
Cr	< 0.1	< 0.02
Cd	0.02	1
Ni	0.8	0.4
Pb	0.06	0.03
Sb	0.08	0.15
Be	< 0.04	< 4
Co	4.2	14
Sn	0.18	0.18
Mo	0.4	0.43
Cu	72	0.36

From table 4 it appears that only a very small part of the original content of elements is leached.

Example 2 (pilot plant scale)

The raw material consists of a mixture of 33 wt% sludge ash, 10 wt% foundry sand, 6 wt% steel grit, 4.0 wt% used fireproof MgO bricks, 11 wt% used garnet, 20 wt% mineralised sludge, 8 wt% used Al_sO_3, and 8 wt% limestone. The mixture is crushed to a particle size that is smaller than 3 mm and melted completely in gas-fired pilot revolving furnace at 1490°C. The result is a melt that granulates after quenching in water. The resulting glass is dried, crushed and sieved to a fraction with a particle size of 0.4-1.4 mm. The sieved fraction was tested as blowing agent in sand blasting of 18/8 steel and steel 37, respectively. A corresponding test was carried out with corundum (HV_{100} = 1800) and aluminium silicate (HV_{100} = 600) sand blasting. The results of the tests performed are shown in the accompanying Fig. 1 and Fig. 2.

Fig. 1 shows the results of sand blasting 18/8 steel where the blowing agents are the glass produced in example 2, aluminium silicate and corundum respectively, and

Fig. 2 shows the result of sand blasting steel 37 where the blowing agents are the glass produced in example 2, aluminium silicate and corundum respectively.

From the figures it appears that the glass according to the invention is significantly better than aluminium silicate and corundum for sand blasting both 18/8 steel and steel 37 irrespective of blasting angle. The glass is just as good as aluminium silicate in sand blasting of 18/8 steel. The best results are however obtained at blasting angles over about 50° (sine 50° = 0.77). The glass proves significantly better than aluminium silicate for sand blasting steel 37 at all tested blasting angles.

Example 3 (industrial scale)

75.5 wt% mineralised sludge, the largest particle size of which is not greater than 4 mm, 1.8 wt% steel grit, 11.5 wt% dolomite, 7.3 used Al_2O_3, and 4 wt% limestone are mixed and briquetted. The water content in the briquettes is 32 wt% and the briquettes have a calorific value of 9.5 MJ/kg. The briquettes are hardened in furnace at 110°C to an average water content of 20 wt%. The briquettes are melted under oxygen supply in blast furnace at 1490°C partly with a supply of coke of 28 wt% and partly with a supply of coke of 10 wt%. The melt is quenched in water. After oxidation at 500°C, an analysis showed that the briquettes had the composition in Table 5:

Table 5

	Content in wt% in supplied mineralised end product	**Content in wt% of mineralised end product at melting with 28% coke**	**Content in wt% in mineralised end product at melting with 10% coke**
SiO_2	41.6	46.2	40.2
Al_2O_3	15.2	16.9	15.3
Fe_2O_3	12.4	4.5	7.2
CaO	14.9	22.2	21.2
MgO	4.3	6.4	6.9
MnO_2	0.2	0.2	0.2
TiO_2	0.9	1.0	0.8
P_2O_5	6.5	1.3	3.7
K_2O	1.6	0.9	1.5
S_{total}	1.0	-	-
C	6.0	-	-
B_i	0.25	0.58	0.57
M_s	1.5	2.15	1.78
M_f	0.81	0.26	0.47

From Table 5 it appears that when a coke quantity of 28 wt% is used, iron and phosphorus smelt out. It also appears that a combination of the energy content in 10 % coke and the calorific value of the briquettes themselves is sufficient to melt the briquettes.

Example 4 (industrial scale, test of hardness and hygroscopic properties)

70.0 wt% mineralised sludge, 7.0 wt% foundry sand, 1.4 wt% olivine sand, 6.2 wt% wood crushed to a size of 20 mm, 8.7 wt% treated grain remainings, 0.9 wt% used garnet, and 5.5 wt% limestone are mixed and mineralised for 40 days. The water content of the briquettes drops during the mineralization from

56.4 wt% to 39.2 wt%, the pyrogas content drops from 37.3 wt% to 25.8 wt%, the charcoal content changes from 12.4 wt% to 13.2 wt%, and the ash fraction increases from 50.3 wt% to 59.8 wt%. The calorific value of the briquettes has dropped from 11 MJ/kg to 8.9 MJ/kg. The mixture is adjusted to five different water contents as indicated in Table 6. The mixture was pressed to briquettes with a diameter of 60 mm and hardened in aerated furnace at 110°C for 1.5 and 3 hours respectively.

Table 6

Test no.	**wt% water**	**Density of hardened briquette (g/cm^3)**	**wt% after 1.5 hours hardening**	**wt% after 3 hours hardening**	**Consistency before hardening**
1	23.3	1.28	-	-	Segregation cracks
2	26.7	1.22	-	-	Solid
3	33.3	1.20	23.0	14.6	Solid
4	39.2	1.16	25.5	16.9	Solid
5	47.1	1.20	-	-	Soft

From Table 6 it appears that at greater water contents, the mineralised raw material becomes so soft that it only can be handled with difficulty in the briquette press. The produced briquettes becomes unhomogeneous and can therefore not provide optimum packing and aeration conditions in the blast furnace.

5 briquettes of each type of briquettes had a total weight of between 800 and 1400 g. Each type of briquettes were put in a bag and analysed by drop test on stone floor. After 5 and 10 drops respectively, the briquette material was sieved on 4 mm sieve. The results of the test are shown in Table 7 below and show that the hardening gives the best result at a water content of between 25 wt% and 35 wt%.

Table 7

Test no.	Hardening time	wt% particles ≥ 4 mm at 5 drops	wt% particles ≥ 4 mm at 10 drops
1	1.5 h	22.7	
	3.0 h		
2	1.5 h	7.8	
	3.0 h	5.9	13.4
3	1.5 h	2.0	
	3.0 h	1.0	11.8
4	1.5 h	1.2	2.4
	3.0 h		2.5
5	1.5 h	1.0	2.0
	3.0 h		2.8

Claims

1. A method for producing a glass produced on basis of a raw material in form of a mixture of mainly mineral-containing components, and where the raw material after initial pretreatment is pressed to dry briquettes that are hardened and subsequently melted in e.g. a blast furnace under oxygen supply, and the melt is quenched and dried, **characterised** in that the pretreatment comprises the steps of:
   - producing a mixture of mineral-containing components from sludge from e.g. purification plant and one or several other mineral-containing waste products and/or natural rocks,
   - thermically decomposing the content of the mixture of soluble organic material, and
   - adjusting the water content of the mixture to between 20-35 wt%, and preferably between 27-33 wt%.

2. A method according to claim 1, **characterised** in that the briquettes are melted under additional energy supply from combustion of a fuel in a quantity of max. 10 wt% of the quantity of briquettes to be melted.

3. A method according to claim 1 or 2, **characterised** in that the briquettes have a density of 1.2 - 1.3 g/cm^3.

4. A method according to claim 1, 2 or 3, **characterised** in that the briquettes are hardened at a temperature of between 75°C and 110°C to a water content of 15 - 20 wt%.

5. A glass of the kind that is produced on basis of a raw material in form of a mixture of mainly mineral-containing components, **characterised** in that the mineral-containing components comprise sludge from e.g.

purification plants and one or several other mineral-containing waste products and/or natural rocks.

6. A glass according to claim 5, **characterised** in that the glass contains more than 30 wt% inorganic components from sludge.

7. A glass according to claim 5 or 6, **characterised** in that the mineral content of the glass is in oxide form and that the weight percentages of the mineral oxides silicon dioxide (SiO_2), dialuminium trioxide (Al_2O_3), diferri trioxide (Fe_2O_3), calcium oxide (CaO), magnesium oxide (MgO) and diphosphorus pentaoxide (P_2O_5) together constitute at least 90 wt% of the glass.

8. A glass according to claim 7, **characterised** in that the ratio of the weight percentages of the mineral oxides calcium oxide to diphosphorus pentaoxide in the glass is determined by the inequation

$$\text{wt\% CaO} \geq 1.33 * \text{wt\% } P_2O_5$$

9. A glass according to claim 7 or 8, **characterised** in that the weight percentages of the mineral oxides calcium oxide, diphosphorus pentaoxide, and magnesium oxide in the glass relate to the weight percentage of silicon dioxide in the glass such that the relation

$$\frac{(\text{wt\% CaO} - (1.33 * \text{wt\% } P_2O_2)) + \text{wt\% MgO}}{\text{wt\% } SiO_2}$$

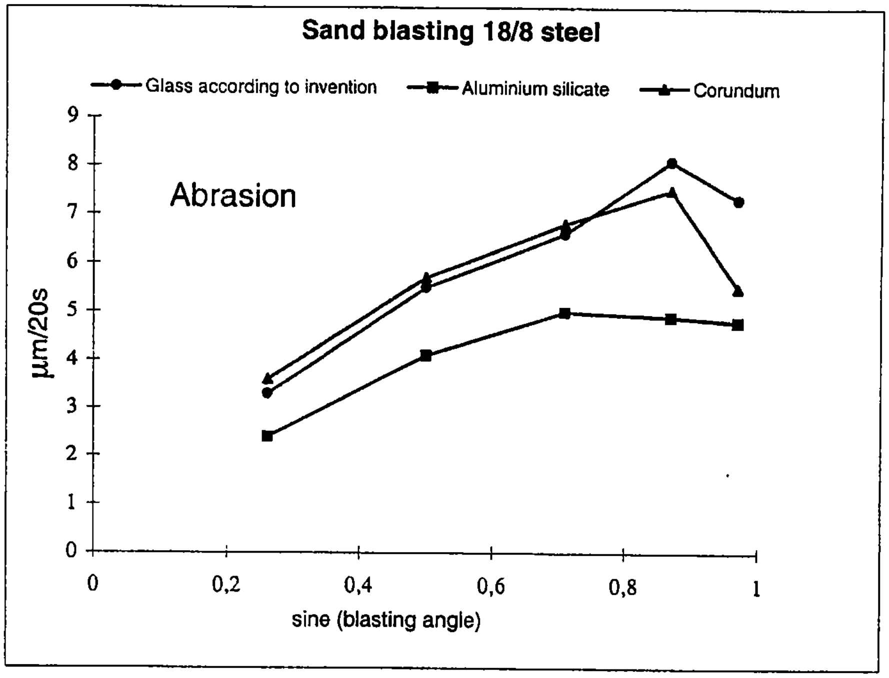
is between 0.15 and 0.5.

10. A glass according to any of the claims 7 - 9, **characterised** in that the ratio of the weight percentages of the mineral oxides diferri trioxide to dialuminium trioxide in the glass is between 0.56 and 1.00, and that the ratio of the weight percentages of silicon dioxide to dialuminium trioxide in the glass is between 2.2 and 3.2.

11. A glass according to any of the claims 5 - 10, **characterised** in that the specific density of the glass is between 2.7 and 3.1 g/cm^3, preferably between 2.8 and 3.0 g/cm^3, and especially 2.9 g/cm^3.

12. A glass according to any of the claims 5 - 11, **characterised** in that the glass has a hardness of $HV_{100} \geq 600$.

13. Use of the glass according to any of the claims 5 - 12 and where the glass is graded, **characterised** in that the graded glass is used for sand blasting.


Sand blasting 18/8 steel
Glass according to invention
Aluminium silicate
Corundum
Abrasion
µm/20s
sine (blasting angle)
0
1
2
3
4
5
6
7
8
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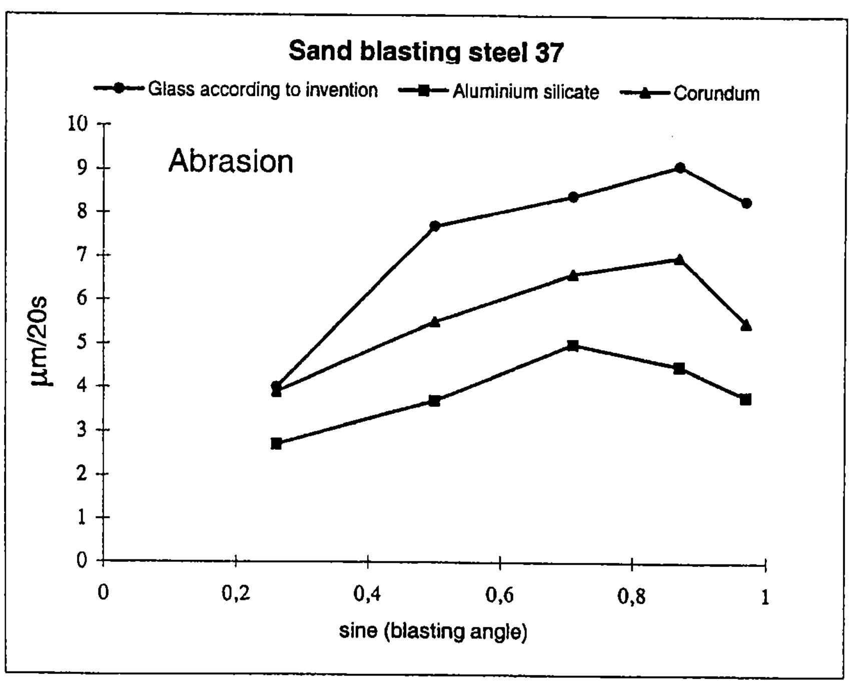
0,4
0,6
0,8

Fig. 1


Sand blasting steel 37
Glass according to invention
Aluminium silicate
Corundum
Abrasion
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sine (blasting angle)
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8
9
10
0,2
0,4
0,6
0,8

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00672

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C03C 1/02, C03B 1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: C03C, C03B, B09B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PAJ,WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	page 5, line 16 - page 6, line 9, claims 1-6, abstract	7-10,12-13
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Y	WO 9534516 A1 (ROCKWOOL INTERNATIONAL A/S), 21 December 1995 (21.12.95), page 4, line 10 - page 5, line 21; page 7, line 5 - page 8, line 21; page 9, line 5 - line 15, claims 1-9, abstract	7-10
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 March 2001	16 -03- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Mattias Arvidsson/MP Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00672

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 4074991 A (STANLEY F. BRZOZOWSKI ET AL), 21 February 1978 (21.02.78), claims 1-6, abstract --	1-13
A	EP 0468414 A2 (KANEKO SENJI ET AL), 29 January 1992 (29.01.92), page 2, line 26 - page 3, line 27, abstract --	1-13
A	DE 4023561 A1 (FELS-WERKE GMBH), 30 January 1992 (30.01.92), claims 1-13, abstract --	1-13
A	US 4720295 A (BORIS BRONSHTEIN), 19 January 1988 (19.01.88), column 7, line 30 - column 8, line 60, abstract -- --------	1-13

INTERNATIONAL SEARCH REPORT
Information on patent family members

05/02/01

International application No.
PCT/DK 00/00672

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